

SENSORY INFORMATION FROM AFFERENT NEURONS

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PROGRESS REPORT #9

For the period

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Summary of Progress in the Ninth Period

During the ninth reporting period we implanted the first three animals (NIH 29, 30, 31) of a new series, designed to test the long-term viability and selectivity of 8-channel Multi-Contact Cuff (MCC) electrode arrays installed on the Sciatic nerve above the knee. The implantation was carried out in two stages. In a first surgery, each subject received four single-channel nerve cuffs, one on the sciatic nerve proximal to the hip joint and the other three on distal branches of the sciatic: the tibial, superficial peroneal and sural nerves. Cuff dimensions are given in Table 1. In the first surgery, each subject was also implanted with EMG electrodes on 6 innervated muscles (Table 1). The stability of the implanted devices was tested the night after implant and once or twice again in the following two weeks. In a second surgery, 2-3 weeks following the first one, the MCC and an additional EMG electrode (MG) were implanted. This procedure was designed to provide baseline data on nerve status and implant stability prior to installation of the MCCs, such that any changes that may follow the MCC implantation can be clearly observed and further tracked over the following six months of the experiment.

All nerve and EMG signals recorded from these subjects were normal to date. Unfortunately, NIH 29 was prematurely lost due to respiratory depression during the night. This happened after the subject had successfully recovered from gas anesthesia following a recording session. We had recently switched analgesics, and started to use a Fentanyl transdermal patch to provide continuous, long-term analgesia during the week after surgery. In NIH 29 we may have miscalculated the injectable analgesic requirement after installation of the Fentanyl patch, during the recovery from gas anesthesia. As a consequence of this mishap, we have revised the injectable analgesic requirements in an effort to maintain safe and effective levels at all times. We intend to make up for the premature loss of NIH 29 by implanting an additional animal in this series.

In NIH 30 we have started to analyze the patterns of multi-channel recorded activity during walking in the awake animal, and the multi-channel stimulation selectivity and the performance of recording MCCs in the presence of FES under anesthesia. We are analyzing the evoked compound action potentials, device impedances and trends in multi-channel recording selectivity using electrical stimulation of the distal cuffs and EMG electrodes under gas anesthesia. We are analyzing the multi-channel patterns of nerve activity during manually imposed joint manipulations and mechanical stimulation of skin sensory receptors under gas anesthesia. In addition, we are analyzing the selectivity with which individual muscles and distal nerves are recruited in response to electrical stimulation of each of the individual MCC electrodes. NIH 31 is scheduled to receive the MCC array early in February, 1999.

Plans for the Tenth Period

During February-April we plan to implant three more animals and continue our ongoing analysis of signals in all implanted animals for a period of six months per subject.

Full Papers Accepted for Publication in the Ninth Period

1. Strange, K. and **Hoffer, J.A.** Gait Phase Information Provided by Sensory Nerve Activity During Walking: Applicability as State Controller Feedback for FES. **IEEE Trans. BME** (accepted; in final revision).
2. Strange, K. and **Hoffer, J.A.** Restoration of Use of Paralyzed Limb Muscles Using Sensory Nerve Signals for State Control of FES during Walking. **IEEE Trans. Rehab. Eng.** (in press).

<u>Nerve</u>	<u>Cuff length (mm)</u>	<u>Cuff diameter (mm)</u>	<u>Cuff type</u>
Sciatic (proximal to hip)	10.5-12.0	3.5-4.0	balanced tripolar
Sciatic (mid-thigh)	25	3.5-3.8	8-channel MCC 4 x bipolar 4 x tripolar
Tibial (shank)	20-23	2.1	balanced tripolar
Superficial peroneal (shank)	20	1.6	balanced tripolar
Sural (shank)	20-25	0.5	balanced tripolar

Table 1: Nerves implanted with cuff stimulating/recording electrodes.

<u>Movements</u>	<u>Muscles Involved</u>	<u>Innervation</u>
Ankle		
Dorsiflexion	Tibialis anterior	Deep peroneal n.
	Extensor digitorum longus	Deep peroneal n.
Plantar flexion	Medial Gastrocnemius	Tibial n.
	Soleus	Tibial n.
	Plantaris	Tibial n.
	Flexor digitorum longus	Tibial n.
Inversion	Tibialis anterior	Deep peroneal n.
Eversion	Peroneus brevis	Superficial peroneal n.
Digits		
Flexion	Flexor digitorum longus	Tibial n.
Extension	Extensor digitorum longus	Deep peroneal n.

Table 2: Muscles implanted with EMG electrodes.